Clean Hydrogen Partnership

FLAGSHIPS Final event

Lionel BOILLOT

22nd September 2026

EUROPEAN PARTNERSHIP

Clean Hydrogen Partnership

Clean Hydrogen Joint Undertaking

EU Institutional Public-Private Partnership (IPPP)

Advisory:
Stakeholder Group
incl all H2 supply chain stakeholders, associations

Advisory:
States Representative Group incl 36 countries represent. (all EU and Associated Countries)

Hydrogen Europe

Industry Association
more than 600 members

European Commission

Hydrogen Europe Research

Research community
more than 150 members

1 billion EURO from Horizon Europe* to **implement R&I activities** and facilitate the transition to a greener EU society through the development of hydrogen technologies

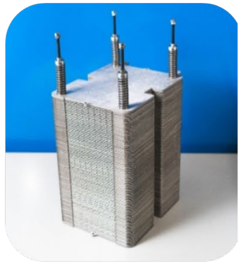
**** additional 200 million EURO for Hydrogen valleys (under RePowerEU)***

Co-funded by the European Union

Clean Hydrogen Partnership

A 18 years journey of the Fuel Cells and Hydrogen JU

From research to delivering hydrogen solutions in the market: from individual applications to H2 Valleys



Manufacturing

Green H2 production

Buses

ships

Aviation

Research

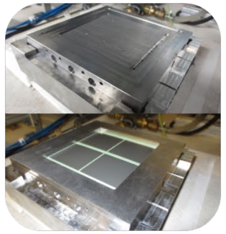
PoC

Domestic heat and power

Heat and power for industry

Heavy duty trucks

Logistics machinery



Materials

Gensets

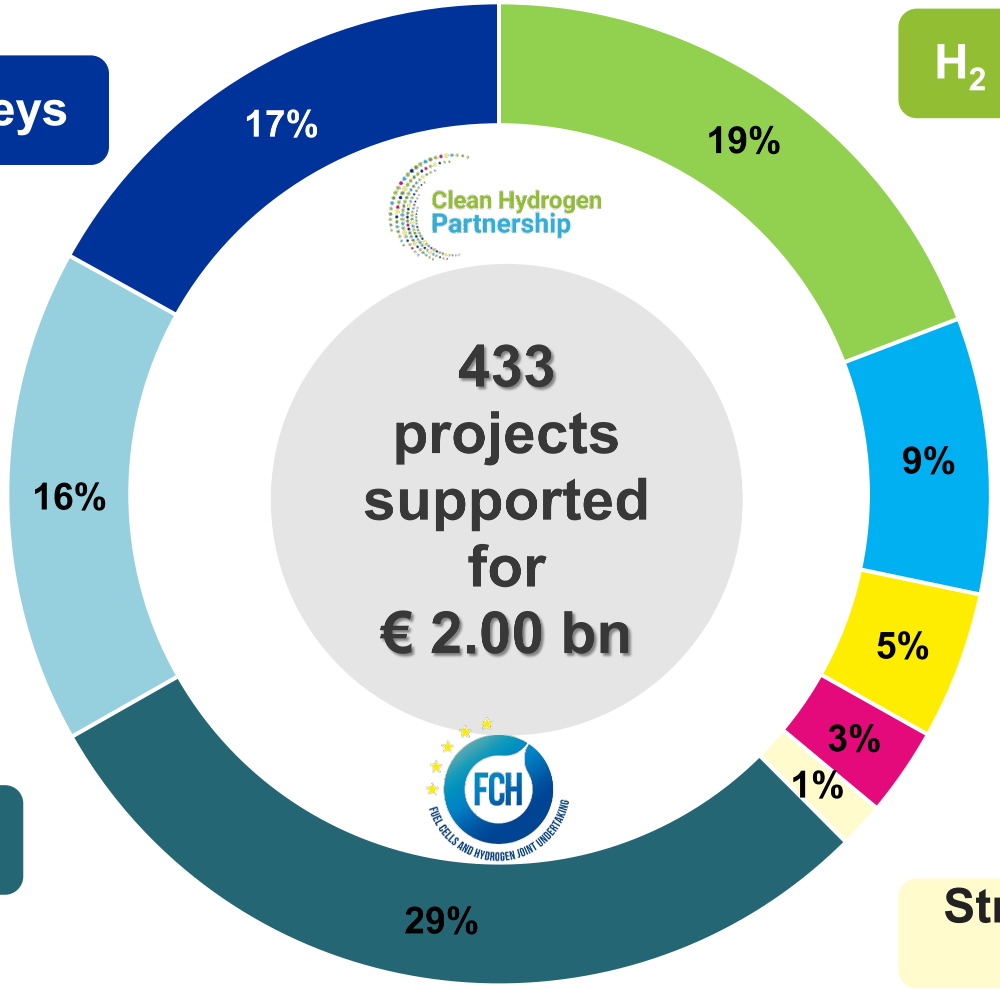
Light duty vehicles

Trains

Clean Hydrogen Partnership

Clean Hydrogen JU Programme

2008-2026 Cumulative funding



H_2 Valleys
27 Projects
€ 320 million

H_2 Production
100 Projects
€ 383 million

H_2 End Use: Clean Heat and Power
93 Projects
€ 325 million

H_2 Storage & Distribution
45 Projects
€ 181 million

Cross-cutting
61 Projects
€ 97 million

Supply Chain
18 Projects
€ 58 million

H_2 End Use: Transport
86 Projects
€ 583 million

Strategic Research Challenge
3 Projects
€ 29.6 million

Co-funded by the European Union

Clean Hydrogen Partnership

Fluvial transport – JU steps and vision

2019 2020 2023 2025

Fluvial

FLAGSHIPS > 1 MW

2 cargo vessels
CH_2 PEM

HEAVENN / 0,38 MW

Barge vessel
CH_2 PEM

5M€ - 2019-2026

Technical feasibility & Mid-size demonstrations

- Develop 100+ kW PEM FC
- Sustain fluvial conditions
- Integrate FC
- Demonstration of mid-size vessels

RH2IWER / 7.5MW

6 inland vessels
CH_2 PEM

15M€ - 2023-2027

Scale-up fleet and FC power

- Min. 5 vessels
- Diversity of vessels
- Min. 500kW FC
- Standardisation FC and H2 storage
- Safety

/ 0.6MW

1 inland vessel
CH_2 PEM

6M€ - 2025-2028

Infrastructure Corridors & H2 Supply Chain

- Port hydrogen ecosystem
- Bunkering infrastructure
- Standardisation and regulation
- H2Tank-Tainers

Co-funded by the European Union

Clean Hydrogen Partnership

State of the art and context at start of FLAGSHIPS

2019 – Existing vessels

Nemo-H2
(60kW PEM)

Alster Wasser
(50kW PEM)

Elektra
(3x100kW PEM)

Context

Market

- IWT already clean vs. trucks
- Small size of the market
- An ageing fleet and long lifetime of vessels

Regulations and standardisation
Absence of rules for:

- Hydrogen as a fuel
- Fuel cells as powertrain
- Hydrogen storage

Technology

- Vessel specific
- Limited pool of suppliers for FC, hydrogen storage and supply
- Hardly compatible with commercial operations

2019 – 2026 FLAGSHIPS

H2 barge 2
(1200kW PEM)

ZULU 6
(400kW PEM)

Clean Hydrogen Partnership

Challenges faced by FLAGSHIPS

Decision and construction

- CAPEX increase and FID not achieved
- Changes in partners commercial strategy
- New demonstration sites and vessel concepts
- H_2 infrastructure and FC technology readiness
- COVID-19 and supply chain disruptions
- Complex regulatory/certification environment

Operations

- OPEX
  - Hydrogen price
  - Bunkering (hydrogen supply)
- Market
  - Customer demand remains sensitive to the cost premium

Many hurdles.

One outcome: the vessels sailed

Co-funded by the European Union

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Important contributions and results achieved

- Partners established their **expertise**
- **More vessel designs, more rivers**
- **Fuel cells system – several manufacturers** have maritime approved systems
- H2 tanks – **swappable containers** became the norm
- **Continuity** under follower projects:

RH2IWER / 7.5MW

6 inland vessels
CH_2 PEM

CleanH2Shipping / 0.6MW

1 inland vessel
CH_2 PEM

And beyond FLAGSHIPS

Regulation and standards

- Revision of ES-TRIN (“inland navigation code”) on:
  - Hydrogen as fuels and fuel cells -2024
  - Hydrogen storage – 2025
- Interoperable infrastructure for refuelling and bunkering via AFIR - end 2026

Joining Forces

- Stakeholders' coalition (RH2INE + national/regional initiatives)
- <10 of H2 fuel cells powered vessels built

Reducing Hydrogen Costs

- Demand aggregation instrument ➔ greater purchasing power
- Shared pool of swappable hydrogen storage

Co-funded by the European Union

Clean Hydrogen
Partnership

Thank you

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the European Union

Maritime CleanTech

FLAGSHIPS webinar

Scaling clean maritime solutions through collaboration

Ada Martine Jakobsen

CEO, Maritime CleanTech

Demonstrating zero emissions

FLAGSHIPS has raised the readiness level of clean shipping in Europe by deploying two hydrogen fuel cell vessels on inland waterways.

Photo: © Future Proof Shipping

Maritime CleanTech | FLAGSHIPS
Clean Hydrogen Partnership
Co-funded by the European Union

Maritime
CleanTech

Proven solutions






Maritime CleanTech | HyShip

Clean Hydrogen Partnership

Co-funded by the European Union

Scaling hydrogen

Two Samskip SeaShuttle container vessels to be powered by PEM fuel cells and LH2.

Photo: © Samskip

Maritime CleanTech | SeaThrive

Supporting maritime alternative fuel projects

SeaThrive aims to transform renewable and low-carbon fuel projects into commercially viable, investable, and implementation-ready maritime ventures.

Maritime CleanTech, maritimes cluster norddeutschland, auxios, VTT, MARE Technology Cluster FVG, DTU, Pôle Mer Méditerranée, LR, Epsilon, Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping

Funded by the European Union

www.seathrive.eu

Photo: Norled, MF Hydra

Maritime CleanTech

FLAGSHIPS

Clean waterborne transport in Europe

Jyrki Mikkola

VTT Technical Research Centre of Finland Ltd.

Final Event

22nd of September 2026

An innovation action under the FCH 2 JU, 2019, grant n:o 826215

Clean Hydrogen Partnership

Co-funded by the European Union

VTT currently coordinates 50 M€ project portfolio on hydrogen ships

Funded by the European Union

VTT

MARANDA

H2+PEMFC based hybrid powertrain system is developed and validated for marine applications

SHIP·AH2OY

Demonstrate safe and scalable solution for zero-emission shipping using LOHC and FC technology.

Development of the first megawatt size PEMFC for maritime use, with a lifetime of 80,000 hours

MiNaMi
MILLION NAUTICAL MILE FUEL CELL SYSTEM

2017 — 2026

Clean Hydrogen Partnership

Co-funded by the European Union

FLAGSHIPS

Development and deployment of two comer-cially operated hydrogen fuel cell vessels.

RH2IWER

Deployment of six commercially operated hydrogen fuel cell vessels.
Standardization of H2&FC containers

Plus many more…

e·SHyIPS ON THE WAVE OF HYDROGEN

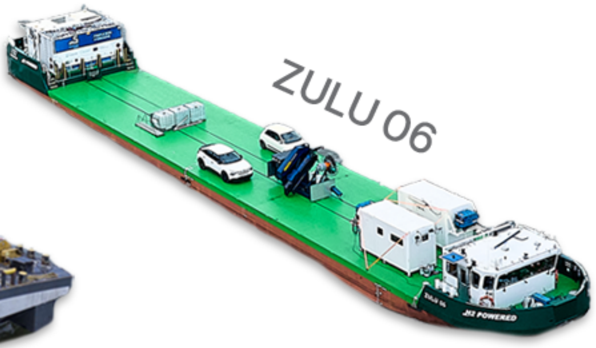
AEGIR

FuelSOME

H2MARINE

FLAGSHIPS

The **FLAGSHIPS** project demonstrates zero-emission waterborne transport with two commercially operated hydrogen fuel cell vessels.

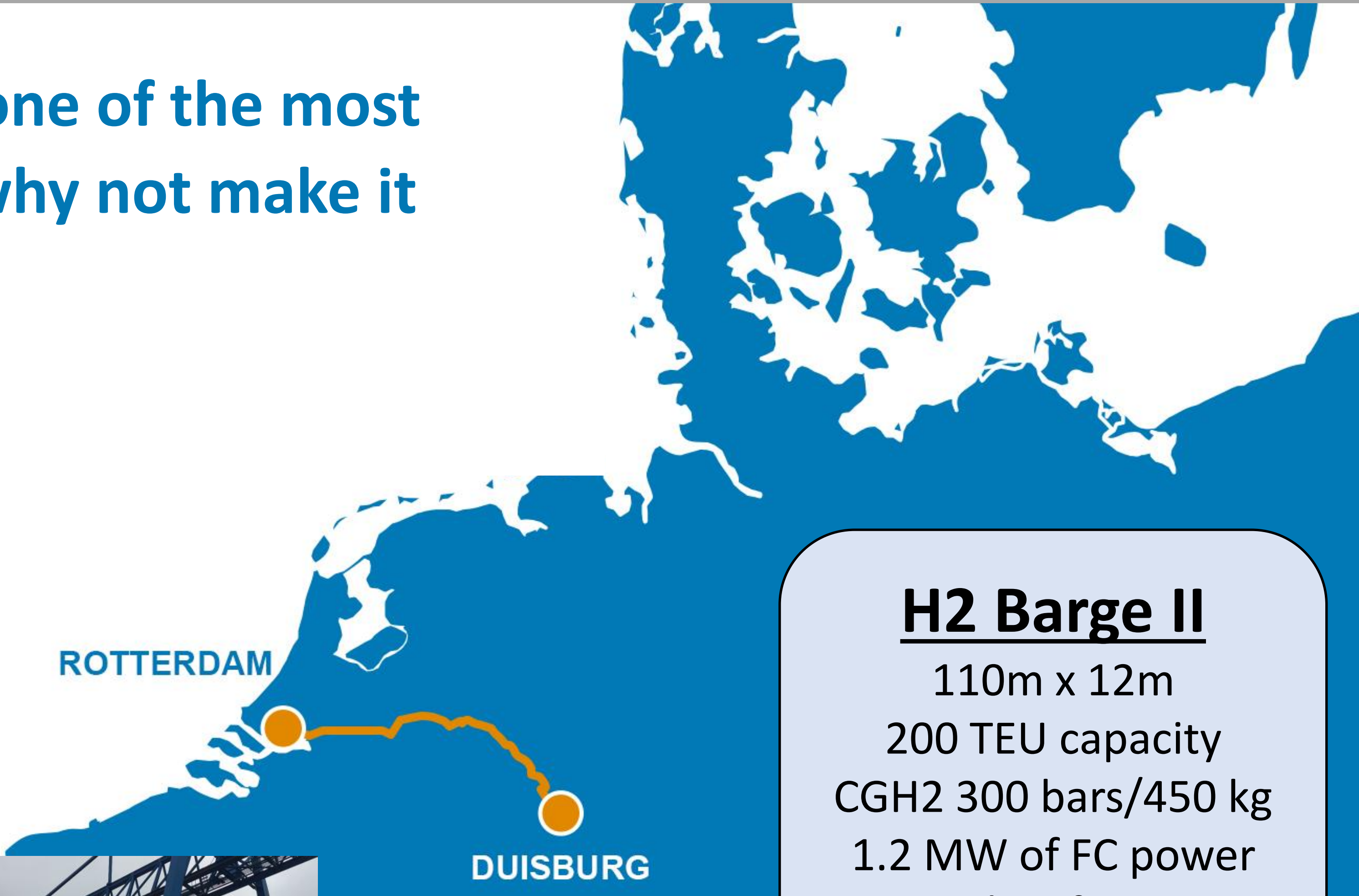


VTT · COMPAGNIE FLUVIALE DE TRANSPORT (CFT, SOGESTRAN GROUP) · SOGESTRAN GROUP · FPS · ABB · BALLARD

Maritime CleanTech · Persee · NORLED · LMG MARIN · SEAM

Clean Hydrogen Partnership · Co-funded by the European Union

Inland waterway transport is one of the most efficient transport modes → why not make it zero emission?



H2 Barge II

110m x 12m
200 TEU capacity
CGH2 300 bars/450 kg
1.2 MW of FC power
21 months of operation

FLAGSHIPS

Clean Hydrogen Partnership
Co-funded by the European Union

Objectives

1) Demonstrate for at least 18 months the operation of a hydrogen-fuelled 1.2 MW power class cargo vessel in the Rotterdam-Duisburg route.
2) Demonstrate for at least 18 months the operation of a hydrogen-fuelled 400 kW power class self-propelled barge in the Paris area, France.
3) Develop the necessary safety measures of said vessels to enable their class approval
4) Develop marine capable PEM fuel cell systems, which meet both technical (lifetime, availability) and business (cost) requirements.
5) Develop and demonstrate bunkering technologies based on swapping gaseous hydrogen fuel containers
6) Foster new European supply chains around zero-emission solutions for the marine and waterborne transport sector

Key takeaways

TECHNICALLY READY	Marine fuel cells, hybrid electrical integration, hydrogen storage, safety systems and approval can be realized already today
APPROVAL	Both demonstration vessels received approval to sail. Approval process still time consuming but keeps developing
OPERATION	H_2 Barge 2 generated extended real-world operating evidence.
CAVEAT	Commercial operation still a bottleneck: demand, hydrogen logistics, finance and operating conditions must also align

The technology is ready to go! The ecosystem must now scale with it.

Acknowledgments

The FLAGSHIPS project has received funding from Clean Hydrogen Partnership (previously Fuel Cells and Hydrogen 2 Joint Undertaking) under grant agreement No 826215. This Joint Undertaking receives support from the European Union's Horizon 2020 research and innovation program and from Hydrogen Europe.

Clean Hydrogen Partnership

Co-funded by the European Union

Contact points

- Coordinator: VTT Technical Research Centre of Finland Ltd.
  - Jyrki Mikkola, jyrki.mikkola@vtt.fi, tel. +358 40 170 1744

FLAGSHIPS

www.flagships.eu

Clean Hydrogen Partnership
Co-funded by the European Union

ZULU 06

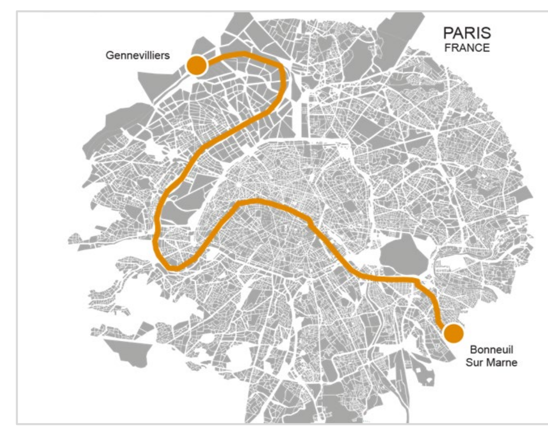
Making Zulu 06 ready for hydrogen operations

[INTERNAL]

ZULU 06

- Urban distribution boat
  - Palletized goods / Big bags
- Onboard crane
- Up to 400 tons of cargo
- 1 week autonomy
- 2 x Ballard Fcwave
  - 4,5 barg service pressure.
- 20’ foot container
  - Type IV composite bottles
- 300 kg at 300 barg @ 15°C
  - Refilled at shore station

Replace up to
50 delivery trucks



ZULU 06
HYDROGEN'S STORAGE

- **ADR compliance**
- 20' foot container
- Type IV composite bottles
- Acoustic sensors
- 3 lines - 13 / 13 / 14 bottles
  - Segregated with normally closed pneumatic valves
- 300 barg
- IR / UV cameras
- Excess Flow valves

ZULU 06
FUEL-CELL & PIPING

- 2 x Ballard Fcwave
- Proton Exchange membrane Fuel-cells technology
- H2 + O2 as fuels
- Products :
  - Water
  - Electricity
  - Heat
- Swagelok Valves
- Set of valves for safety and operations
- 4,5 barg service pressure.

ZULU 06
NUMEROUS CHALLENGES

- From Romania during COVID
- To the navigation certificates

  -> 4 years

Major milestones :

Safety studies

- HAZID / HAZOP / FMECA analysis

Design loops

- H2 piping and valve system
- Container solution
- Skids for electrical equipment

Sizing of equipment

- Batteries packs
- Safety valves
- …

Selection & certification of suppliers

ZULU 06
READY TO SAIL

<u>Major milestones :</u>

Steel work & retrofit
- Openings in deck
- Railings for the container guidance
- Fuel cell room, …

EU & French authorities' approval
- EU committees in Strasbourg
- French “recommendation” meetings

Teaching courses for crew
- Safety courses
- Operation courses

Harbour test & sea trials
- H2 testing
- Fuel cell testing

ZULU 06
STRONG CONSORTIUM

Collaboration is key to accelerate the green shift

Learn more about the group : Sogestran Group
Learn more about the project : Zulu 06

Hydrogen fuel cells for zero-emission shipping

FLAGSHIPS Final Event

Andrew Win
Market Development Manager

Sustainable Power Now

Clean Hydrogen Partnership
Co-funded by the European Union

Ballard Power Systems – Enabling Zero-Emission Marine Transport

- Ballard Power Systems – fuel cell technology for heavy-duty and commercial applications.
- Decades of experience developing PEM fuel cell technology for demanding applications.
- Experience across buses, trucks, rail and marine.
- FCwave: modular marine fuel cell technology designed for scalable power requirements.
- Supporting the transition toward zero-emission marine transport through technology, collaboration and commercial deployment.

Building Experience for Commercial Marine Applications

- Worke with partners to develop and integrate fuel cell solutions for commercial marine applications.
- Ballard supplied FCwave fuel cell modules for the two FLAGSHIPS demonstration vessels.
- Collaboration with shipowners, vessel designers and project partners.
- Technical support for fuel cell system design and vessel integration.
- Commissioning of the fuel cell modules.
- Service and maintenance support through the operation phases.

FCwave – A Milestone in Marine Fuel Cell Technology

- FCwave: modular 200 kW marine fuel cell engine.
- Scalable architecture for different vessel power requirements.
- First DNV Type Approval for a marine fuel cell module, achieved in 2022.
- On top of **safety validation**, the DNV Type Approval also includes functionality for heavy duty conditions, such as,, **Structural Integrity, Emissions, Performance, Efficiency, Noise, Vibration, and Environment**
- Flagships formed the foundation for the development of commercial marine fuel cell applications.

Looking Ahead – From Demonstration to Commercial Marine Deployment

Samskip – Short-Sea Cargo Opportunity

Ballard supplying FCwave fuel cell technology for two Samskip feeder vessels.

Vessels planned to operate between Norway and the Netherlands.

Collaboration with vessel and system integration partners to support the development of fuel cell propulsion solutions.

Future Marine Market Focus

Inland and cargo vessels.

Passenger ships.

Short-sea cargo vessels.

Continued engagement with shipowners, vessel designers, shipyards, integrators and hydrogen infrastructure partners.

Following developing marine fuel cell opportunities in Norway.

SEPTEMBER 22, 2026 – FLAGSHIPS FINAL EVENT

ABB Marine Fuel Cell (MFC) Solutions

Timo Keränen, R&D Product Manager – Fuel Cell Solutions

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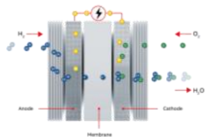
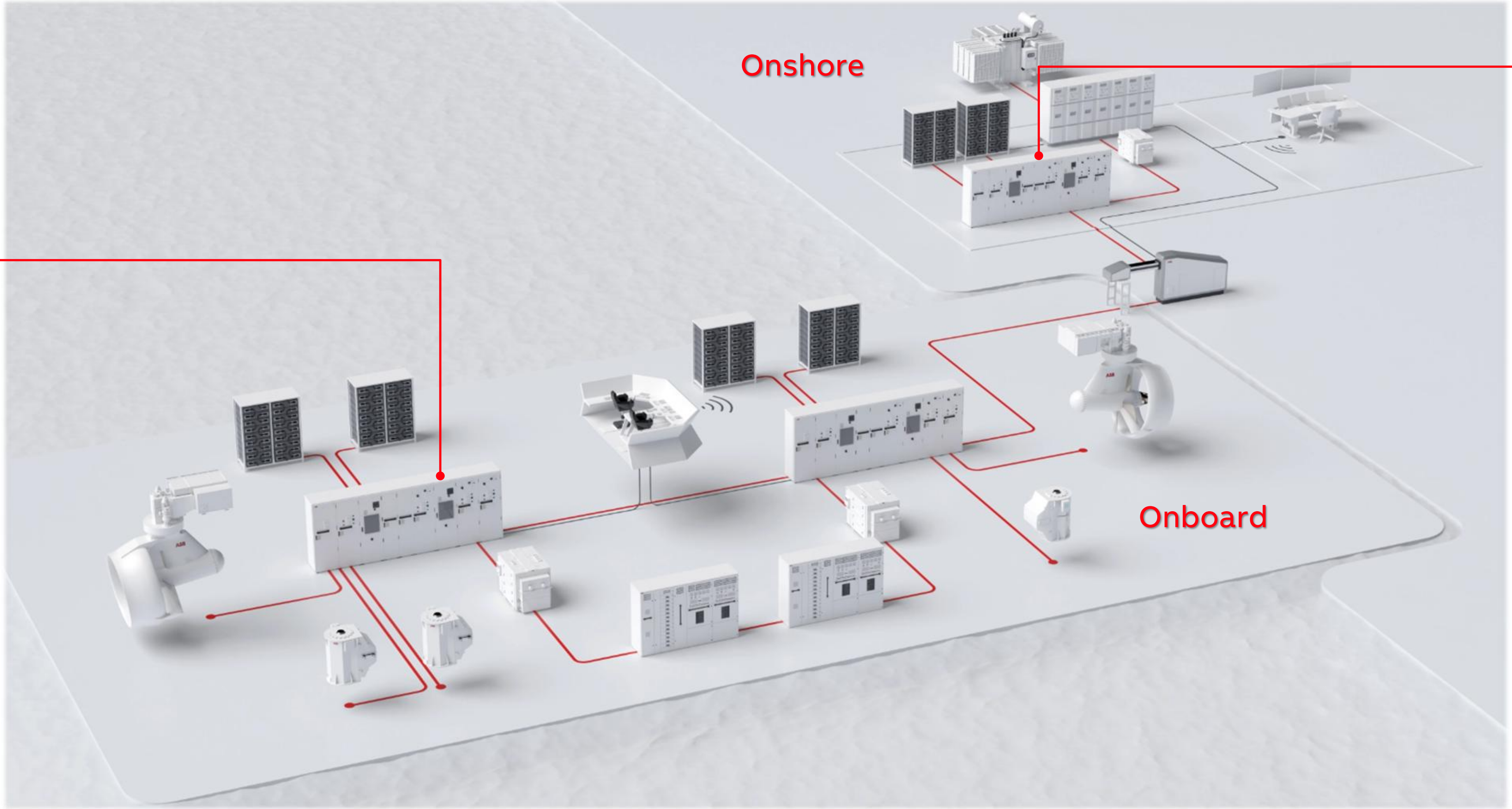
ABB MFC solutions

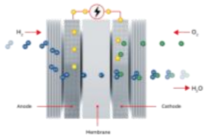
ABB Marine Fuel Cell (MFC) solutions

Application in marine power systems



Using MFC solutions onboard with AC or DC systems and SG solutions





Using MFC solutions onshore for shore connection or charging

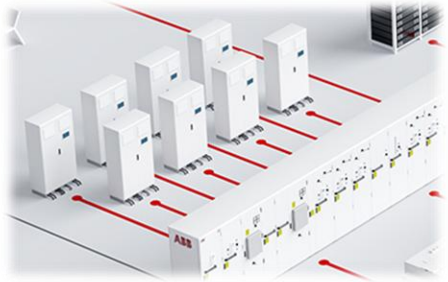
SG: shaft generator

ABB Marine Fuel Cell (MFC) offerings

Overview

MFC Integration

Scalable and flexible systems that can be connected to variety of selected certified (PEM or solid oxide) marine fuel cell modules of different power ratings with fuel cell control and power management for both shore and onboard marine systems



MFC eHouse

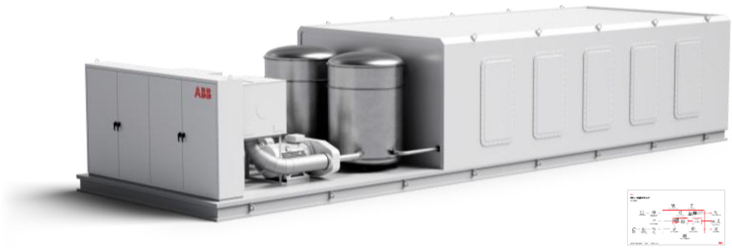
Integrated certified marine PEM fuel cell modules in a container with complete piping, GVU, and integrated safety systems for both shore and onboard marine systems

MFC Skid

Integrated certified marine PEM fuel cell modules on a skid with complete piping, and GVU

MFC High Power

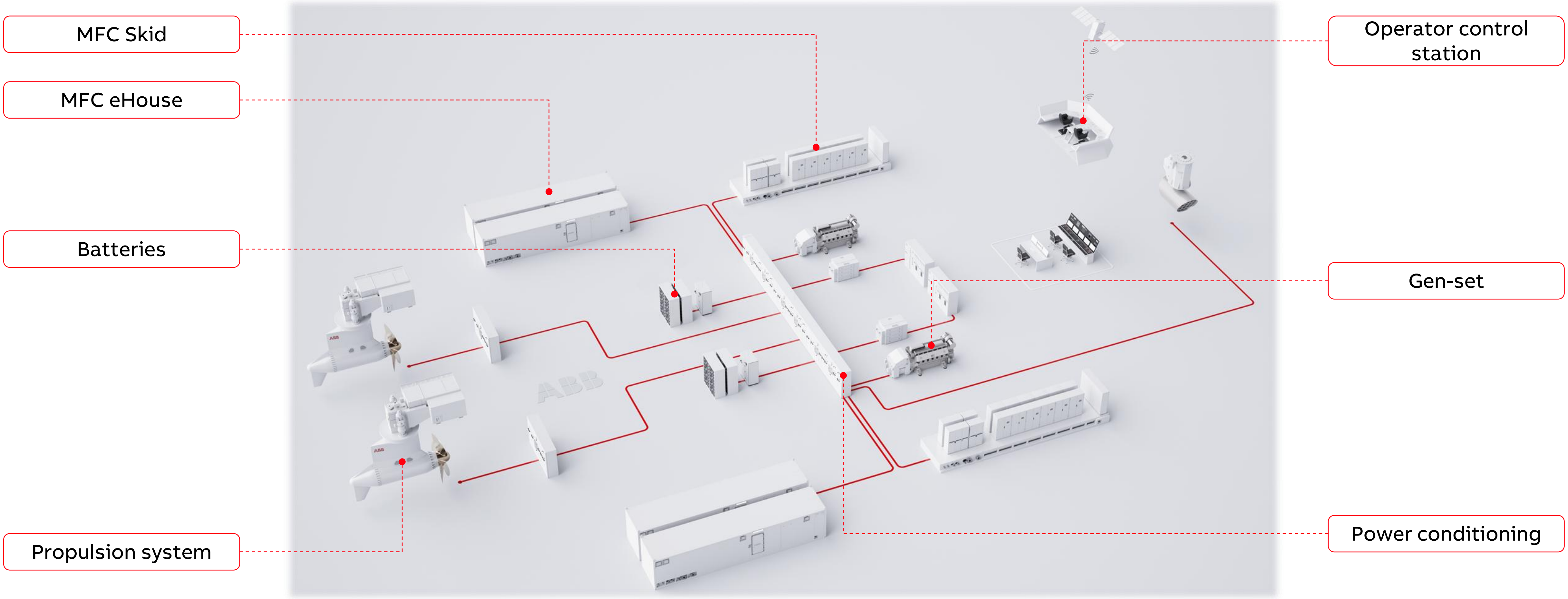
Integrated next generation PEM fuel cell building blocks in single high power unit



PEM: proton exchange membrane fuel cell; BoP: Balance of Plant; MFC: marine fuel cell

Typical marine power system with MFC

Illustrative example



02

Reference projects

Reference projects

Marine fuel cell installations integrated by ABB

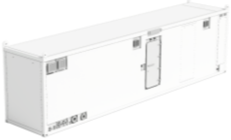
System integration of two demonstrators: 100 kW fuel cell system with Hydrogenics, and another 100 kW with Ballard for Royal Caribbean

Fuel cell technology demonstrators

Research project with 400 kW fuel cell system on hydrogen powered river container vessel

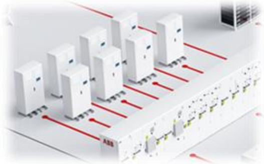
FLAGSHIPS river container vessel

EU funded project, where ABB marine and ports will develop a 400kW containerized fuel cell system



Baltic Sea H2 research project

Marine newbuild project with Onboard DC Grid™ and MW-scale fuel cell system



MW-scale fuel cell project

2017 → 2026

MARANDA arctic research vessel

Research project to develop 165 kW fuel cell system for an arctic research vessel

Feadship Breakthrough

Superyacht with Onboard DC Grid™ and 3 MW fuel cell system

Samskip H2 vessel

Two feeder container vessels with Onboard DC Grid™ and 3.2 MW hydrogen fuel cells

MiNaMi research project

Development of next generation multi-MW fuel cell architectures

ABB

INSIGHTS FROM FLAGSHIPS

Maritime Gaseous & Liquid Hydrogen Transfer

Integrating GH2 fast-fill thermal models, LH2 fireball hazard correlations, and open safety e-tools from the FLAGSHIPS initiative

DELIVERY PATHWAYS

Marine Hydrogen Delivery Modes

4 OPERATIONAL TRANSFER MODES EVALUATED IN EUROPEAN MARITIME TRIALS

Truck-to-Ship (TTS)

Flexible pilot project delivery.

Shore-to-Ship (STS)

High-volume terminal piping.

Ship-to-Ship (STS)

Scalable commercial barge transfer.

Swappable Containers

Modular swap-tank swapping.

WEBINAR CONTEXT

The Maritime Hydrogen Scaling Challenge

SCALING FROM AUTOMOTIVE PROTOTYPES TO HIGH-FLOW COMMERCIAL VESSEL BUNKERING

IMO 2050 Mandate

Zero-emission propulsion requirements driving green hydrogen adoption.

Massive Flow Scale

Bunkering rates 100x higher than land FCV station protocols.

Remaining regulatory gaps for H2 transfer

ISO 24132 covers LH_2 ship–shore transfer interface but no maritime LH_2 bunkering protocol in place

FLAGSHIPS DELIVERY PATHWAYS

Swappable containers as a by-pass to regulatory gaps

Truck-to-Ship (TTS)

Flexible pilot project delivery.

Shore-to-Ship (STS)

High-volume terminal piping.

Ship-to-Ship (STS)

Scalable commercial barge transfer.

Swappable Containers

Modular swap-tank swapping.

FLAGSHIPS

FUEL STATES COMPARISON

GH2 vs. LH2 Transfer Dynamics

DISTINCT PHYSICAL MECHANISMS REQUIRE DEDICATED PROTOCOL PHYSICS

Persee

Compressed GH2

350 - 700 Bar

State: High-pressure gaseous transfer

Target Vessels: Inland ferries & push-boats

Physical Stress: Adiabatic compression heating

Core Limit: Tank wall liner temp ceiling (<85°C)

FLAGSHIPS Tool: Pressure ramp thermal simulation

Cryogenic LH2

-253°C (20 K)

State: Deep cryogenic liquid state

Target Vessels: Ocean cargo & large ferries (Stavanger)

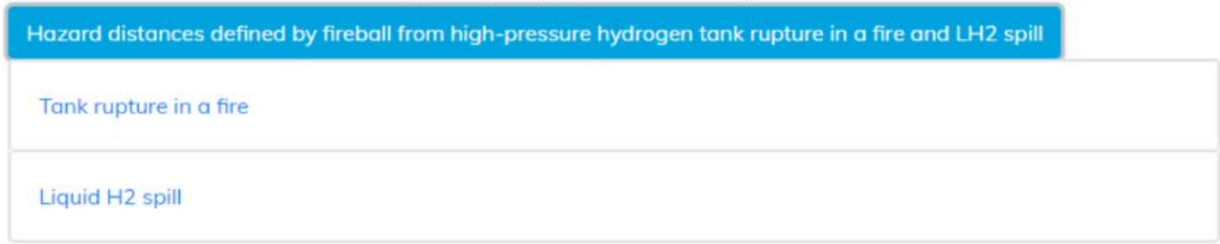
Physical Stress: Boil-off gas (BOG) & line chill-down

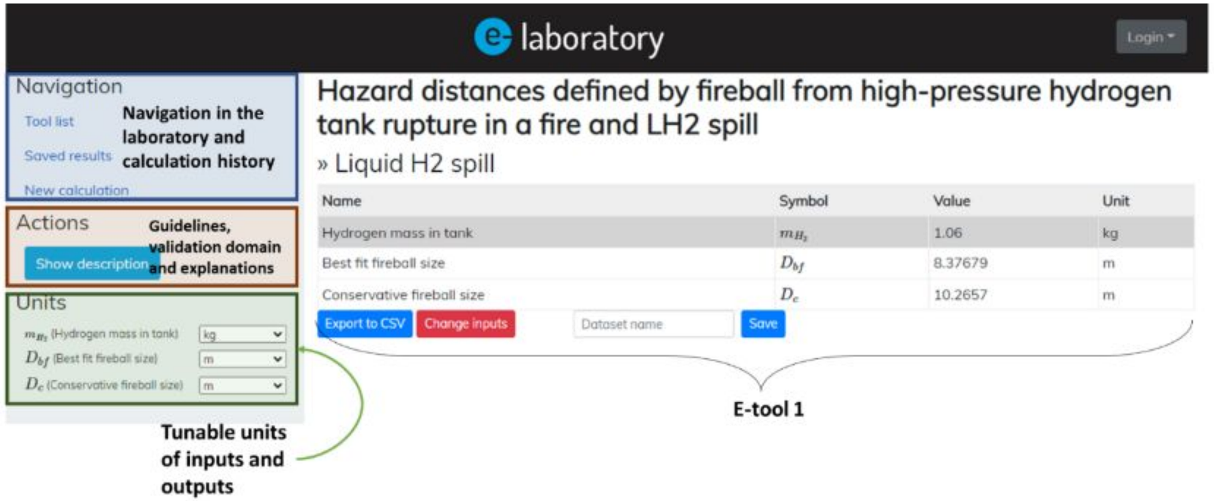
Core Limit: thermal shock

FLAGSHIPS Tool: LH2 spill fireball hazard distances

LH2 spill hazard distance evaluation

https://elab.hysafer.ulster.ac.uk/





The model consists of two options to allow for the calculation of hazard distances defined by:

1. The size of fireball after high-pressure gaseous hydrogen tank rupture in a fire
2. The size of fireball after liquid hydrogen spill

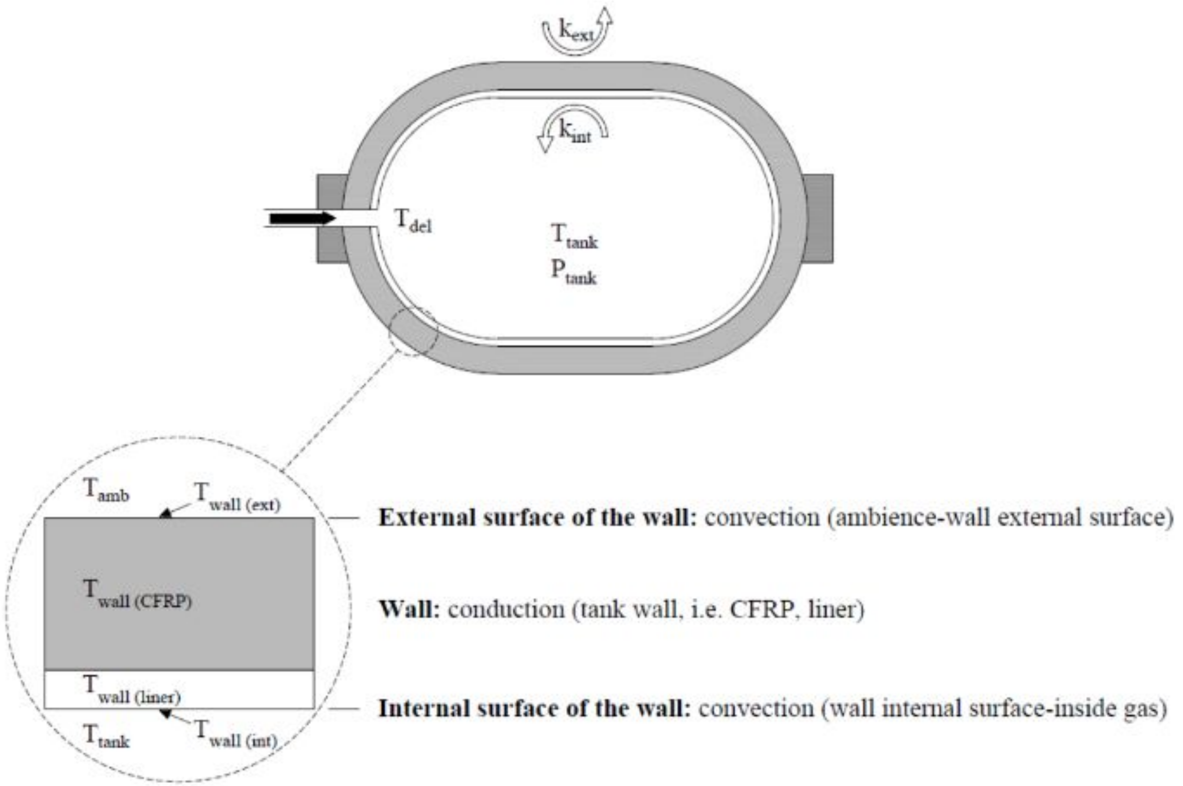
The output is an estimation of the fireball diameter in case of rupture, with both best fit and conservative fit.

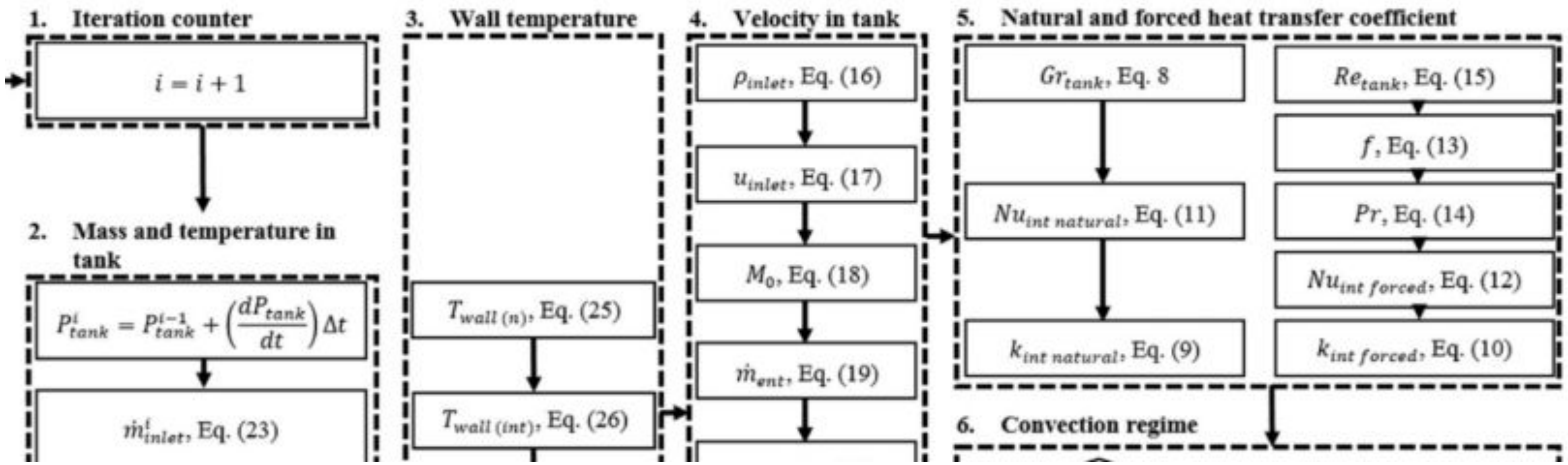
FLAGSHIPS E-TOOL FOCUS

GH2 fast fill evaluation

https://elab.hysafer.ulster.ac.uk/

This second tool aims to facilitate the development of fueling/bunkering protocols for compressed hydrogen storage systems (CHSS).
The calculations are based on the physical model of thermal behavior of hydrogen storage tank.
The model and tool account for all main underlying physical phenomena during hydrogen fueling of a composite high-pressure cylinder.
The model has been validated against fueling experiments with Type III and Type IV tanks typical for onboard storage.





Persee

Persee

LOOKING FORWARD

Let’s ensure H2 Transfer can be an industrialised and cost effective process!

FLAGSHIPS

FLAGSHIPS

The impact of FLAGSHIPS

Aleksandra Saarikoski, VTT

Clean Hydrogen Partnership
Co-funded by the European Union

The impact of FLAGSHIPS

- Implementation of fuel cell vessels
  - FLAGSHIPS has succeeded in demonstrating the implementation of two fuel cell vessels: H2 Barge 2 by FPS and Zulu 06 by CFT.
- Completed approval processes for both demo vessels
  - Hydrogen is not currently a commonly utilised fuel in maritime. The case-by-case approval process was completed successfully for both vessels.
- CO2 emission reductions
  - Approximately 2400 tCO2 emission reductions were reached during the project.
  - Comparisons made to a conventional diesel-operated vessel.

Clean Hydrogen Partnership
Co-funded by the European Union

Successful outreach and dissemination

[FLAGSHIPS wins Best Outreach Award at EU Hydrogen Week 2024]

FCW.

Hydrogen EV Investors Research Knowledge Contact

HYDROGEN

FLAGSHIPS Wins Prestigious Award at EU Hydrogen Week

By Fuel Cells Works
November 26, 2024 at 11:28 AM EDT

Listen 4:29

[The launch event of Zulu 06]

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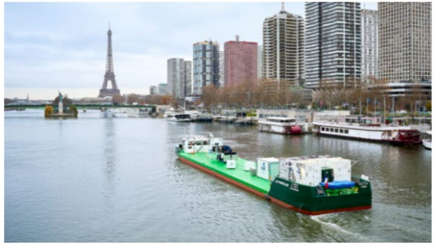
HYDROGEN

Hydrogen-powered Zulu 06 launches in Paris

By MATT ROSS — December 6, 2024 2 Mins Read



France's first hydrogen-powered river vessel, the Zulu 06, launched on the Seine in Paris at the start of December.

[The launch event of H2 Barge 2]

OFFSHORE ENERGY

Green Marine Hydrogen Marine Energy Subsea Fossil Energy Alternative

Home > Hydrogen >

Hydrogen-powered inland containership H2 Barge 2 wraps up its first trials

VESSELS

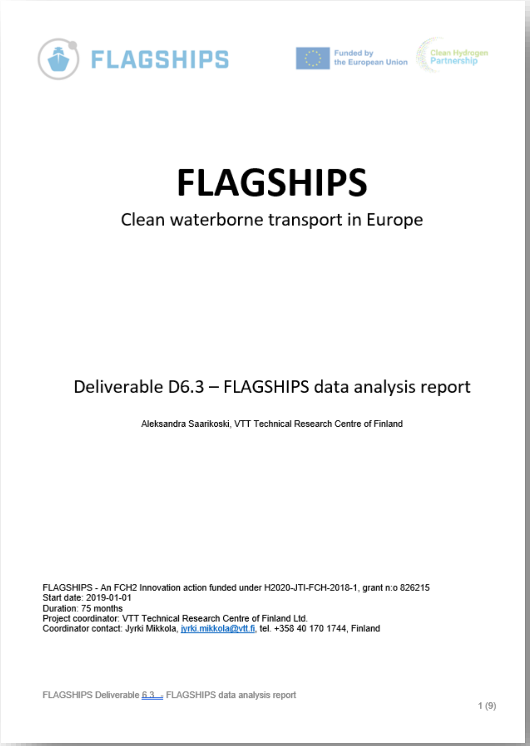
March 6, 2024, by Ajsa Habibic

H2 Barge 2, a second inland containership converted to run on hydrogen by Dutch shipbuilder Holland Shipyards Group for compatriot shipowner Future Proof Shipping (FPS), has completed its first trials.

Courtesy of Future Proof Shipping

FLAGSHIPS Data analysis

- Data from the demonstration vessels H2 Barge 2 and Zulu 06
- Both demonstration vessels are using the maritime type-approved FCwave system by Ballard.
- More than 21 months of vessel operation in total and at least 5000 hours of operation.
- An estimated total of 2400 tCO_2 emissions reduced during the project.
- The results are presented in the deliverable 6.3 ”FLAGSHIPS Data analysis report” (Public)



FLAGSHIPS

Funded by the European Union

Clean Hydrogen Partnership

FLAGSHIPS

Clean waterborne transport in Europe

Deliverable D6.3 – FLAGSHIPS data analysis report

Aleksandra Saarikoski, VTT Technical Research Centre of Finland

FLAGSHIPS - An FCH2 Innovation action funded under H2020-JTI-FCH-2018-1, grant n:o 826215
Start date: 2019-01-01
Duration: 75 months
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FLAGSHIPS Deliverable 6.3 – FLAGSHIPS data analysis report

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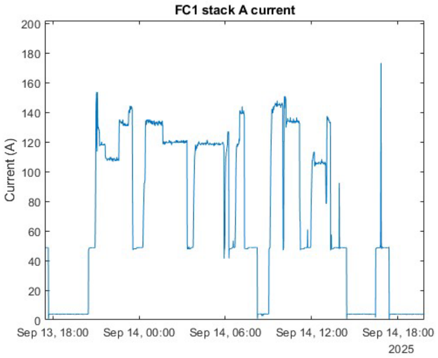
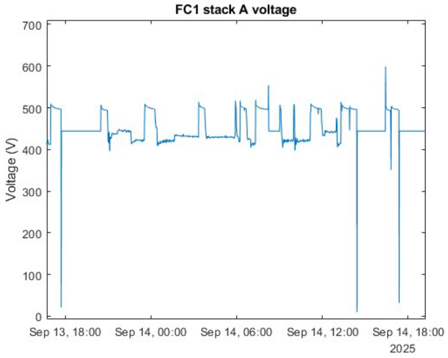
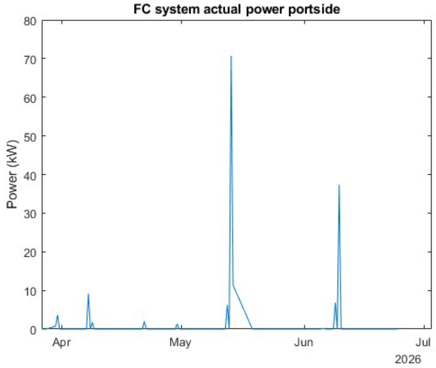
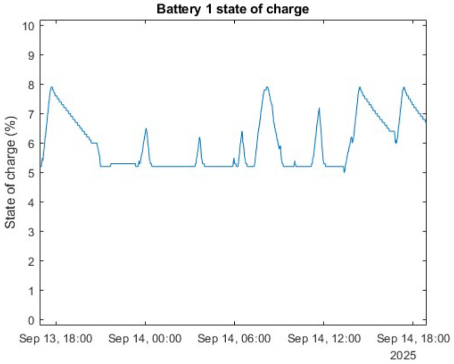
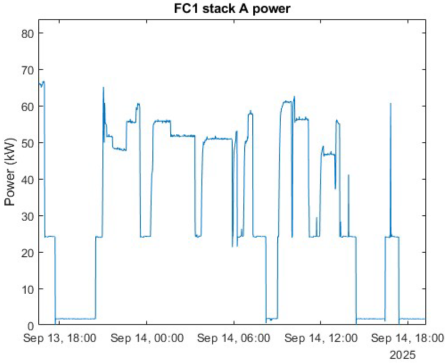
FLAGSHIPS Data analysis

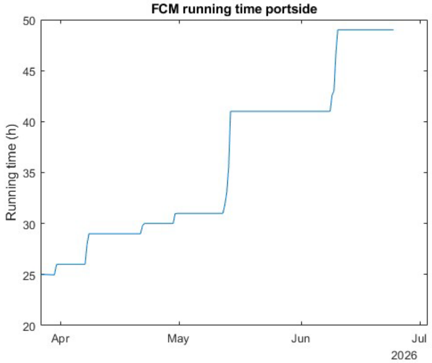












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Lessons learnt

- Increasing hydrogen availability and supply
  - Hydrogen availability and supply is one major barrier for fuel cell vessel implementation. Hydrogen supply is limited and expensive when produced in small volume.
- Addressing financial bottlenecks and tackling business case challenges
  - The gap between fossil fuels and alternative fuels, such as hydrogen, must be closed for a successful business case – especially OPEX cost.
  - The inland waterway sector is decentralized with several small and medium-sized enterprises with limited financing possibilities. Retrofitting or construction of new builds can prove to be a challenge.
- Streamline the approval processes
  - Technical requirements (ES-TRIN) for alternative fuel or fuel cell vessels missing or incomplete – approval is based on a lengthy case-by-case safety assessment.
  - Increase the competence of fuel cell vessels with authorities to streamline the approval process.

Recommendations

- Increase hydrogen availability and supply
  - Coordinated implementation of REDIII and support for demand pooling.
- Improve bunkering infrastructure and refuelling standards
  - Hydrogen bunkering and refuelling infrastructure to be made available at ports. Inconsistent design, the compatibility of equipment, and varying safety regulations create barriers for cross-border hydrogen logistics and limit scalability.
- Strengthen the regulation and decarbonization targets
- Further support ship owners and operators
  - Ship owners and operators remain major risk takers when investing in zero-emission or fuel cell vessels. Importantly, the gap between fossil fuels and hydrogen should be closed.
- Streamline approval processes
  - Technical requirements for vessels to include fuel cells and hydrogen to avoid the case-by-case derogation process. Authorities to increase competence and experience with zero-emission vessels to streamline the approval process.

Acknowledgements

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